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Effects of Static Stretching on Functional Capacity in Older Women: Randomized Controlled Trial

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ABSTRACT

Gallo LH, Gurjão ALD, Gobbi S, Ceccato M, Prado AKG, Jambassi Filho JC, Gomes ARS. Effects of Static Stretching on Functional Capacity in Older Women: Randomized Controlled Trial. **JEPonline** 2015;18(5):13-22. The purpose of this study was to analyze the effects of static stretching on functional capacity of older women. Thirty-one older women (68.2 ± 7.4 yrs) were randomly assigned to two groups: Control Group ($n = 16$) and Training Group ($n = 15$). Functional capacity was assessed by a motor test battery and the global functional fitness index (GFFI) calculated by summing the scores of all motor tests. Maximal voluntary contraction was evaluated during unilateral isometric knee extension. After 8 wks of training, the TG had significantly ($P < 0.001$) better flexibility levels (59.0 ± 9.9 cm) than the CG (49.5 ± 10.1 cm). The TG also improved the GFFI overall classification, which changed from "Fair" (200-299 points) to "Good" (300-399 points), while the CG remained classified as "Fair". No difference was observed between groups for the other variables. Thus, the findings indicate that static stretching training is effective in improving flexibility and general functional activities in older women.

Key Words: Flexibility, Static stretching, Physical fitness, Aging

INTRODUCTION

Good levels of flexibility and muscle strength are related to the effectiveness in carrying out activities of daily living (ADLs) and, consequently, in the maintenance of functional independence in older adults (10,17). On the other hand, lower flexibility and decrease in muscle strength of the shoulders, hips, and ankles are associated with an increase in difficulty carrying out activities such as combing hair and putting on shoes, besides the negative changes in postural control and gait patterns that contribute to falls (6,10,17).

Stretching routines have been recommended either as part of the warm-up or as the main component of an aerobic and muscle strength exercise program (2). However, the small number of randomized controlled studies do not permit the determination of the safe and effective types of stretching exercises and prescription parameters for the older population (2,28).

Different authors (16,19) have demonstrated that stretching exercises promote significant increases in joint range of motion due to change in the mechanical and/or neural properties of the neuromuscular system. Among the mechanical factors, changes in the muscle-tendon unit viscoelasticity may promote better reuse of elastic energy during the muscle stretch-shortening cycle, which increases the work capacity of a given muscle group (12,19). The better use of elastic energy during dynamic activities, associated with the increased joint range of motion (ROM), can make activities like climbing stairs, sitting in a chair, and standing up from a chair easier, thus positively influencing the performance in ADLs (12).

However, the results are still contradictory. Some studies have shown that stretching training promotes gains in ROM and improves gait parameters (7,9,11,13,23), muscle strength (12,13,23), agility, and the ability to walk in older adults (12,23). Other studies found no improvement due to stretching training on gait parameters (26), muscle strength (3,14), and agility (13).

Therefore, the objective of this study was to analyze the effects of static stretching training on functional capacity and its components (i.e., flexibility, coordination, agility, strength, and aerobic endurance) in community living older women. It was hypothesized that the training program would be effective in improving the subjects' flexibility, muscle strength, and functional capacity (via General Functional Fitness Index).

METHODS

Subjects

This study was approved by local Research Ethics Committee (protocol number 0896). After receiving information about the study and agreeing to participate, the subjects signed an Informed Consent.

The criteria for selection of the subjects included the following: (a) female; (b) 60 yrs or older; (c) had not practiced systematic physical activity two or more times a week in the six months prior to the study; (d) had no present mental, neurological, muscular or osteoarticular contraindications that would limit the subjects from undergoing the training and evaluation protocol; and (e) had no history of a musculoskeletal injury during the six months prior to the

study. Subjects were excluded from the sample if they missed one evaluation, training the session frequency was less than 80% of the total or who missed five consecutive sessions.

Initially, 67 older subjects showed interest in participating, but 35 subjects were excluded for not meeting the study criteria (Figure 1). Thus, 32 older women were selected to take part in this study. One subject did not attend the initial assessments and was excluded. Thus, 31 older women were randomly separated into 2 groups by means of a random number table: Control Group (CG, $n = 16$) and Training Group (TG, $n = 15$). Throughout the trial period the following were excluded from the sample: (a) two from the CG and one from the TG for not having the minimum required frequency; (b) one subject from CG and one from TG for not showing up for the final evaluation due to an injury unrelated to the intervention. In addition, one CG subject took part in the final evaluation, but did not complete all the tests due to a fall.

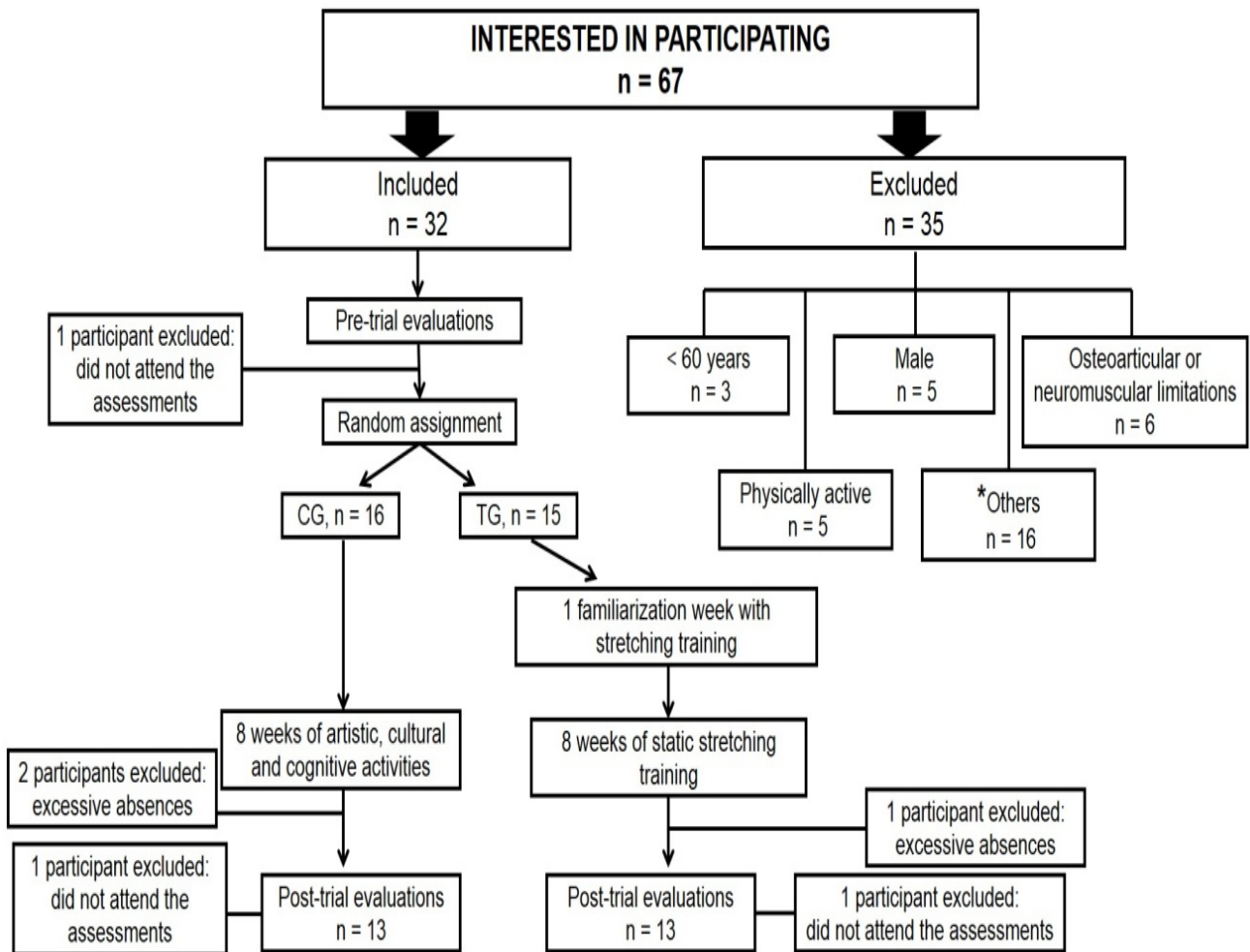


Figure 1. Randomized Controlled Trial Flow Chart and Study Design. *Other limitations to taking part were time, place, and lack of interest. CG: Control Group; TG: Training Group

Procedures

In the pre- and post-trials, the subjects attended the laboratory for assessments involving anthropometric, functional capacity components, mobility, and maximal voluntary contraction (MVC) of the lower limbs. Physical Education professionals with previous experience monitored the training and evaluations, and a Psychology professional supervised the CG. At the end of the trial period, the two groups were reversed.

The Modified Baecke Questionnaire for Older Adults was used to characterize the sample level of physical activity in three specific areas: (a) housekeeping; (b) sports; and (c) leisure activities (24). The functional capacity components were evaluated by the American Alliance for Health, Physical Education, Recreation and Dance (AAHPERD) motor test battery for older adults, which assesses six components of functional capacity: (a) flexibility; (b) coordination; (c) agility; (d) dynamic balance; (e) strength endurance of upper limbs; and (f) aerobic endurance. Percentile points were assigned to the values obtained in each test according to pre-established tables (4,27). The General Functional Fitness Index (GFFI) was determined by using the scores that were obtained in all the tests to assess the global functionality of the subjects.

The isometric force-time curve of the knee extensor muscles was determined in a chair attached to a force transducer (model 5000 NTM, System Brasil® EMG) during a maximum isometric unilateral extension effort of the dominant knee. The subjects remained seated with the hip and knee fixed to the chair and positioned at 90° (15). The signal from the force transducer was acquired by means of an analog signals amplifier (EMG 800C-USB model, System Brazil® EMG, São José dos Campos, SP, Brazil) with a sampling frequency of 2000 Hz. The MVC was determined as the highest value recorded during the entire evaluation (1). Both in the pre-trial and post-trial times, the older women attended the laboratory for four consecutive days, with three days for familiarization with the evaluation protocol (25) and one experimental day, with a minimum of 24-hr visit intervals.

The subjects were instructed to carry out the MVC as fast as possible for 5 sec. Each subject was verbally encouraged. Three measurements were made with 1-min intervals between them (5). The greatest muscle strength recorded of the three attempts was regarded as the subject's MVC value. All procedures were carried out at the same time of day to reduce any possible circadian variations.

The stretch training protocol lasted 8 wks and consisted of 8 different active static stretching exercises, alternately holding the upper and lower limbs, in open (hip extensor and knee flexor muscles) and closed (hip flexor, knee extensor and ankle, shoulder and elbow flexor, and extensor muscles) kinetic chain, for both limbs. All subjects attended the 40-min sessions 3 times·wk⁻¹ at the University. The TG performed exercise at the maximum amplitude, three repetitions each of 30 sec and a 30-sec interval between repetitions (2). The CG took part in artistic, cultural, and cognitive activities with ludic and social interaction characteristics (e.g., movies discussion), 3 times·wk⁻¹ during the 8 wks.

Statistical Analyses

The one-way ANOVA was used to compare the subjects at the baseline. Parametric data (flexibility, coordination, agility, strength endurance, aerobic endurance, and MVC) were analyzed by a two-way ANOVA (2 x 2) for repeated measures to compare the groups and time evaluations, and the Tukey *post hoc* test was used to identify specific differences. The

non-parametric data (GFFI) were analyzed by the U Mann Whitney and the Wilcoxon tests, for intergroup and intragroup comparisons, respectively. The statistical significance was set at $P < 0.05$. All calculations were performed using the same statistical software (SPSS, 20.0).

RESULTS

There were no significant differences between TG and CG regarding age (TG: 69.9 ± 8.6 yrs, CG: 66.6 ± 6.0 yrs, $F = 1.25$, $P = 0.275$), body mass index (TG: 27.6 ± 4.6 kg·m⁻², CG: 30.3 ± 5.6 kg·m⁻², $F = 1.88$, $P = 0.183$), and physical activity levels (TG: 2.5 ± 0.5 score, CG: 2.3 ± 0.6 score, $F = 0.51$, $P = 0.482$) at the baseline.

The TG improved GFFI overall classification, which changed from "Fair" (200-299 points) to "Good" (300-399 points), while the CG remained classified as "Fair". It is important to mention that in the post-trial time evaluation, 54% of the TG participants were classified as "Good" or "Very Good", while only 33% of the CG were classified in these ratings. However, there were no statistically significant differences between the two groups' GFFI evaluations post-trial ($z = -1.17$, $P = 0.24$) (Table 1).

Table 1. General Functional Fitness Index (GFFI) Values (Median and Range) and Its Classification in the Pre-Trial and Post-Trial Evaluations for Both Groups.

	Training Group			Control Group		
	Median	Range (min-max)	Overall classification	Median	Range (min-max)	Overall classification
Pre-trial	266	64 - 395	Fair	233.5	30 - 439	Fair
Post-trial	341*	147 - 433	Good	281.5*	82 - 437	Fair
Δ%	28.2%			20.6%		

TG; training group, **CG**; control group, **Δ%**; mean percentile variation. *Intragroup analysis - significant difference in relation to pre-trial time ($P < 0.05$); Classification according to Benedetti et al. (19) and Zago and Gobbi (20).

With respect to the components of functional capacity and mobility, a significant Group versus Time interaction was only found for flexibility ($P < 0.001$; $F = 29.70$). Coordination showed better values ($P < 0.001$, $F = 19.17$) and agility ($P < 0.001$, $F = 26.47$) after the trial period of TG. No statistically significant change was found for aerobic endurance, MVC, and strength endurance (Table 2).

Table 2. Functional Capacity Components and Maximum Voluntary Contraction.

	TG (n = 13)	CG (n = 12)	ANOVA effects	F	P
Flexibility (cm)			Group	2.19	0.153
Pre-trial	52.1 ± 12.4	49.4 ± 9.1	Time	30.42	<0.001
Post-trial	59.0 ± 9.9 [†]	49.5 ± 10.1	Group x Time	29.70	<0.001
Coordination (sec)			Group	0.55	0.467
Pre-trial	13.4 ± 3.9*	11.8 ± 3.0	Time	19.17	<0.001
Post-trial	10.9 ± 2.4 [†]	10.9 ± 2.2	Group x Time	4.12	0.054
Agility (sec)			Group	0.05	0.821
Pre-trial	25.5 ± 4.8	24.7 ± 4.0	Time	26.47	<0.001
Post-trial	23.5 ± 4.1 [†]	23.5 ± 3.1	Group x Time	1.90	0.181
Strength endurance (number of repetitions)			Group	<0.001	0.98
Pre-trial			Time	17.73	<0.001
Post-trial			Group x Time	<0.001	0.99
Aerobic endurance (sec)			Group	0.03	0.870
Pre-trial	554.5 ± 101.4	548.7 ± 83.3	Time	1.09	0.308
Post-trial	532.6 ± 109.9	551.7 ± 111.5	Group x Time	1.89	0.182
MVC (N)			Group	1.85	0.186
Pre-trial	216.9 ± 51.2	255.9 ± 87.8	Time	0.28	0.599
Post-trial	221.0 ± 61.0	259.0 ± 89.2	Group x Time	<0.01	0.945

Values (mean ± SD). **TG**; training group, **CG**; control group, **MVC**; maximum voluntary contraction. *significant difference in relation to CG (P<0.05); †significant difference in relation to pre-trial evaluation (P<0.05).

DISCUSSION

Eight weeks of static stretching training promoted an improvement in flexibility and the GFFI overall rating in older women. At the end of the trial period, the GFFI classification of the TG had changed to "Good" while the CG was still classified as "Fair". Although both groups showed better values in the post-trial evaluation, the percentage gain was greater for the TG compared to the CG (28% vs. 21%, respectively). These results are in agreement with the literature (13,20).

Gallo et al. (13) observed improvements of 37% and 31% on average of GFFI for groups who trained with three repetitions of 30 sec and 60 sec, respectively, and the overall classification changed from "Fair" to "Good" after 16 wks of training. On the other hand, the control group improved only by 19% in GFFI and was still classified as "Fair". Pauli et al. (20) found improvements of 34% in the GFFI values and in the overall classification (changed from "Good" to "Very Good") for the group that took part in 12 yrs of general training (various exercises, including stretching exercises), while the values of the control group got worse (22%) as did their classification (going from "Good" to "Fair"). It is important to note that the control groups adopted in these studies (13,20) did not take part in any systematic activity during the trial period; whereas, in the present study the CG also attended the University, which could have motivated the subjects and improved their GFFI average.

The improvement in flexibility found in this study is consistent with the results found in the literature (13,21,23). The TG showed an improvement of 13% in trunk and hip flexion

flexibility, which was determined by the sit and reach flexibility test. Similar gains were demonstrated in a classic study by Rider and Daly (21) after 30 static trunk stretching sessions, with a total volume of 30 sec to 50 sec. Using the same evaluation method, we found a 15% improvement in flexibility values after intervention. Christiansen (7) trained older people with active static stretching exercises 2 times·d⁻¹, 7 d·wk⁻¹ with a volume of 135 sec (three repetitions of 45 sec), during 8 wks and found improvements of 11% for hip flexion movement. Gallon et al. (14) and Costa et al. (8) used a total volume of 240 sec (four repetitions of 60 sec) of stretching during 8 and 12 wks, respectively. The authors found improvements of 30% (14) and 16% (8) in hip flexion. The results found in these studies indicate that the greater volume of training the greater flexibility gains.

There were no significant differences for agility, aerobic endurance, and mobility. These results agree with those of Klein et al. (18) who found no improvement in agility after 20 stretching sessions of proprioceptive neuromuscular facilitation stretching. On the other hand, studies with various training protocols (higher volumes and different stretching methods) have shown improvements of 8% (12), 12% (23), and 14% (3) in agility tests, and 7% (12) and 11% (23) in aerobic endurance/walk tests. Besides the better hip, knee, and ankle ROM (3,7,9), the agility improvement is also related to the greater muscle strength in the lower limbs after the training period (3,23). This appears to be due to the relationship between muscle strength in the lower limbs, gait speed, and the number of steps (22).

In the present study, no significant differences were observed for the MVC of the lower limbs, although both groups showed better strength resistance values of the upper limbs after the trial period. Gallon et al. (14) observed no changes in the knee extension or flexion peak isokinetic torque (concentric and eccentric) values after a stretching training period. Batista et al. (3) showed that 8 sessions of active static stretching training, with 7 repetitions of 60 sec promoted no significant improvement in knee flexion or extension peak torque. However, the authors found higher results for peak torque (e.g., ~11% for knee flexion and 10% for knee extension). Stanziano et al. (23) observed significantly higher values for upper (right = 46% and left = 14%) and lower (17%) limb muscle strength endurance, and for lower limb power (26%). Changes in the elastic properties of the musculoskeletal system and the better reuse of elastic energy that results from the stretching training appear to be responsible for the improvement in muscle strength levels (and, in particular for endurance strength) (3,12,23).

The lack of improvement in the muscle strength of the lower limbs, agility, and aerobic endurance (i.e., walking) may be related to short duration of the intervention protocol and the training volume of 90 sec. The present study had the following limitations: (a) the small number of subjects; (b) the program length; and (c) the absence of a multiple joint ROM evaluation.

CONCLUSIONS

The primary finding from this study indicates that 8 wks of static stretching training with a volume of 90 sec is effective in improving the flexibility and overall functional fitness performance of older women. Considering that the stretching exercises did not require any specific materials to practice and were easy to understand, this study has important practical applications. In addition, this training could be an important ally for the maintenance of

functional independence. Therefore, we encourage the implementation of stretching exercises in physical activity programs for older individuals.

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